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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

MOISTURE ABSORPTION OF HOT-MELT COATINGS

FINAL REPORT

Report No. ChE-11

Chemical Engineering Branch
DIVISION OF RESEARCH

OFFICE OF CHIEF ENGINEER
DENVER, COLORADO

June 3, 1964

CONTENTS

ABSTRACT

In order to understand the effects of certain properties of protective coating materials on corrosion protection, it is desirable to study these properties without the effects of corrosion present. The moisture absorption properties of various hot-melt coatings have been so investigated for periods up to 14-2/3 years. It was found that low penetration coal-tar enamel established the lowest absorption rate of the 11 materials tested. It was also found that after 5 years each material reached a stabilized moisture absorption rate. This report covers the performance of four materials remaining in test after 8 years of exposure. Previous progress reports are referenced.
ChE-11
Selander, C. E.
MOISTURE ABSORPTION OF HOT-MELT COATINGS--FINAL REPORT
Bureau of Reclamation, Denver, 4 p, 7 fig, 3 tab, 3 ref, June 1964
DESCRIPTORS--Asphalt/asphalt enamel/ coal-tar pitch/ coal-tar enamel/ waxes/ coatings/ *hot-melt coating/ *moisture absorption/ time/ absorption rate/ corrosion
IDENTIFIERS--Immersion exposure/ properties/ percent gain/ grams per square foot gain

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Office of Chief Engineer
Division of Research
Chemical Engineering Branch
Denver, Colorado
June 3, 1964

Report No. ChE-11
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Reviewed by: P. W. Lewis
Submitted by: L. O. Timblin, Jr.

Subject: Moisture absorption of hot-melt coatings--Final Report

INTRODUCTION

The moisture absorption properties of various hot-melt coatings have been investigated for periods ranging from 13 to 14-2/3 years. Previous studies on this investigation have been covered in Progress Reports 1, 2, and 3.1/ This report covers the performance of four materials, two coal-tar enamels, a coal-tar pitch, and an asphalt enamel, continued in exposure since the last report. Other materials included in the program were filled and unfilled asphalts, and two waxes. This is the final report on this program.

CONCLUSIONS

Previous conclusions are still in order. These are:

1. Coal-tar base materials as a group show lower total moisture absorption than asphaltic materials.

2. For each basic material (coal-tar enamel, asphalt enamel, etc.), the lower its penetration the less moisture it absorbs.

3. The coal-tar enamels absorb less water, by percent, than the coal-tar pitch.

4. The asphalt enamels generally absorb less water than the unfilled asphalts, although there is overlapping of the higher penetration asphalt enamel and the lower penetration asphalt.

5. The total moisture absorbed increases for all materials as the exposure time increases. None of the materials show a maximum absorption for the period tested.

1/References listed at end of report.

6. The moisture absorption rates have become essentially stabilized after 5 years' immersion.

In addition to the above, the following conclusion is drawn after the continued exposure:

7. The low penetration coal-tar enamel has the lowest average moisture absorption rate, 0.27 percent by weight per year.

MATERIALS

The coal-tar materials used in these studies were two coal-tar enamels with penetrations of 5 and 14 and a coal-tar pitch with penetration of 11. The coal-tar enamels were selected as representative of enamels used by the Bureau as coatings for steel water pipe. The pitch was selected as representative of the trashrack coating used extensively by the Bureau. These materials are still typical of the types currently being specified.

The asphaltic coatings were represented by three materials, a P_2O_5 catalytically blown asphalt with a penetration of 50 and air-blown asphalts with penetrations of 11 and 28. The catalytically blown asphalt represents canal membrane lining material, and the blown asphalts represent typical roofing asphalts. In addition, three asphalt enamels with penetrations of 6, 8, and 1 between 4 and 8 (exact value not determined) were included at a later date. These were selected as representative of asphalt enamel pipeline coatings.

For comparison purposes, two waxes were studied, a paraffin wax melting at approximately 135° F and a microcrystalline wax composition melting at 150-160° F with a penetration between 30 and 40. The microcrystalline wax is of the type used as a rust preventative.

TEST PROCEDURES

Circular brass discs, provided with a hole in the center for suspension of the specimen and measuring 2-1/4 inches in diameter by 1/16 inch in thickness, were cleaned, weighed, and dipped in the melted materials. The coatings were applied at temperatures best suited to give a smooth, continuous film without pinholes and with a thickness dependent upon the nature of the material. Two discs were coated with each material. The coated disks were cooled, weighed, and allowed to stand at room temperature overnight before being submerged in water.

Glass rods bent to form hooks on both ends were used to suspend the coated discs. Glass fruit jars were filled almost to capacity with tapwater and the specimens suspended by the glass rods from screw eyes soldered to the jar lids near the center of the water mass in the containers. The containers and contents were then stored in a 50 percent relative humidity, 73° F constant temperature room.

When readings were taken, each specimen was removed from the water, the excess water blown off the surface with compressed air, and the weight taken as rapidly as possible.

The moisture gain was calculated as the percent gain based on the weight of the original coating and as the gain in grams per square foot of surface area. The percent gain is more indicative of the moisture absorption properties since the thicknesses varied between coatings.

TEST RESULTS

Table 1 lists the original weights of the coatings and their actual gain in grams after the various periods of immersion in tapwater. Table 2 lists the gain in weight of the coatings as a percentage of the original weights, and Table 3 shows the gain in weight in grams per square foot of surface area for the same periods of immersion.

The averages of the data in Tables 2 and 3 for periods up to 12 years are presented graphically in the previous report, No. P-87, and reproduced as Figures 1 and 2 in this report. These data for the last four materials under evaluation through the full test period are presented graphically in Figures 3 and 4 of this report.

A typical container and specimen during storage are shown in Figure 5. Actual size photographs of one specimen from each remaining set are shown in Figures 6 and 7. These were taken after the last readings shown in Table 1.

DISCUSSION

The results recorded in Tables 1, 2, and 3 and Figures 3 and 4, as discussed in previous reports, are relative rather than absolute values.

The positions of the curves for each material are different between the percent water absorbed graphs, Figures 1 and 3, and the gain in grams per square foot graphs, Figures 2 and 4. This difference occurs primarily because of differences in the thicknesses of the coatings. Of the two results, the percent gain is considered more indicative

because the entire mass of the coating is considered rather than just the exposed surface.

After 8 years, only four materials were in condition suitable for continued exposure. These are the three coal-tar materials and one asphalt enamel. All of the other materials have degraded by cracking, flaking, peeling, or decomposition. The asphalt enamel has completed 13 years of exposure, and the coal-tar enamels and pitch have completed 14-2/3 years of exposure. The exposures have now been discontinued.

A maximum moisture absorption was not reached by any material during the test exposures. All show increased absorption as time increases.

The moisture absorption rates of the materials under test for more than 5 years have become fairly stabilized as shown by the uniform slopes of the performance curves of Figures 1 and 3. The lowest rate, 0.27 percent by weight per year, was evident in the low penetration coal-tar enamel.

Except for the specimens which degraded, the relative order of performance has not changed in approximately the last 10 years of exposure.

REFERENCES

1. Fowler, A. L., "Moisture absorption of hot-melt coatings--Progress Report," Report No. P-45, February 23, 1951, ADMINISTRATIVE CONFIDENTIAL.

2. Selander, C. E., "Moisture absorption of hot-melt coatings--Progress Report," Report No. P-61, July 30, 1956.

3. Selander, C. E., "Moisture absorption of hot-melt coatings--Progress Report," Report No. P-87, September 13, 1961.

A

ORIGINAL WEIGHTS OF THE COATINC

Disc No.	Material	Pen.	Original weight	1	4	6	9	12
1	Microcrystalline wax	--	4.2131	0.0101	--	0.0112	--	0.013
2	Microcrystalline wax	--	4.2603	0.0099	--	0.0142	--	0.017
3	Coal-tar enamel	5	9.8932	0.0177	--	0.0283	--	0.034
4	Coal-tar enamel	5	7.4294	0.0124	--	0.0235	--	0.032
5	Coal-tar enamel	14	11.1088	0.0075	--	0.0107	--	0.016
6	Coal-tar enamel	14	10 1338	0.0084	--	0.0122	--	0.016
7	Coal-tar pitch	11	3.2749	***				
8	Coal-tar pitch	11	1.5860	0.0067	--	0.0092	--	0.016
9	Asphalt, P_2O_5 catalytically-blown	50	4.1385	0.0288	--	0.1167	--	0.189
10	Asphalt, P_2O_5 catalytically-blown	50	7.1686	0.0435	--	0.1406	--	0.234
11	Asphalt, air blown	28	4.3924	0.0323	--	0.0471	--	0.098
12	Asphalt, air blown	28	4.2506	0.0274	--	0.0462	--	0.073
13	Asphalt, air blown	11	4.0660	0.0397	--	0.1038	--	0.156
14	Asphalt, air blown	11	3.9507	0.0436	--	0.1260	--	0.178
15	Paraffin	--	2.3409	*-0.0027	--	**0.0047	--	0.004
16	Paraffin	--	1.3885	None	--	**None	--	None
11a	Asphalt enamel	4-8	19.3654	0.0417	0.1102	--	0.1379	--
12a	Asphalt enamel	4-8	20.0615	0.0353	0.0852	--	0.1363	--
13a	Asphalt enamel	6	10.0303	0.0409	0.0792	--	0.1190	--
19	Asphalt enamel	6	10.0135	0.0365	0.0634	--	0.1221	--
18	Asphalt enamel	8	7.7501	--	--	0.1440	--	0.162
20	Asphalt enamel	8	7.5950	--	--	0.1434	--	0.175

*Indicates a loss in weight.
**Paraffin coatings showed minute cracks.
***Specimen damaged. Discarded from test.
****Coating flaking and peeling. Discarded from test.

1/New data since September 1961.
2/Coating very slimy, partly removed in drying, not a true value.
3/Coating flaking slightly, not a true value.
4/Specimen damaged slightly--no value determined.

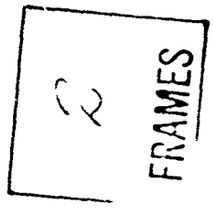


Table 1

INGS AND THEIR ACTUAL GAIN IN WEIGHT AFTER IMMERSION IN TAPWATER FOR TIME INTERVALS AS NOTED

	Gain in weight (grams) at the number of months indicated																							
12	18	21	24	30	33	36	40	44	48	54	60	66	72	78										
0137	0.0194	--	0.0273	0.0232	--	--	0.0251	--	0.0351	0.0429	--	0.0516	--	--										
0170	0.0242	--	0.0414	0.0377	--	--	0.0484	--	0.0493	0.0532	--	0.0642	--	--										
0343	0.0415	--	0.0619	0.0616	--	--	0.0767	--	0.0854	0.0872	--	0.1003	--	--										
0320	0.0380	--	0.0497	0.0552	--	--	0.0728	--	0.0646	0.0679	--	0.0776	--	--										
0165	0.0262	--	0.0484	0.0520	--	--	0.0682	--	0.0840	0.0930	--	0.1191	--	--										
0166	0.0303	--	0.0170	0.0204	--	--	0.0396	--	0.0605	0.0697	--	0.1061	--	--										
0167	0.0160	--	0.0196	0.0244	--	--	0.0354	--	0.0392	0.0444	--	0.0580	--	--										
1899	0.5312	--	0.8694	1.7132	--	--	3.0475	--	3.4049	****														
2343	0.7795	--	1.5189	2.8543	--	--	4.7120	--	5.5603	****														
0986	0.1334	--	0.2190	0.1847	--	--	0.3437	--	0.4477	****														
0731	0.0884	--	0.1083	0.1388	--	--	0.2753	--	0.3276	****														
1564	0.1969	--	0.2245	0.2594	--	--	0.3285	--	0.3742	0.4278	--	0.5330	--	--										
1788	0.2129	--	0.2480	0.2801	--	--	0.3467	--	0.3801	0.4514	--	0.5633	--	--										
0046	0.0147	--	***																					
ne	0.0008	--	0.0074	0.0098	--	--	0.0239	--	0.0282	0.0369	--	0.0953	--	--										
--	0.2044	--	--	0.2741	0.3125	--	--	0.3807	--	--	0.5196	--	0.6336	--										
--	0.2112	--	--	0.2698	0.3091	--	--	0.3813	--	--	0.5017	--	0.6198	--										
--	0.1667	--	--	0.2217	0.2615	--	--	0.3193	--	--	0.4298	--	0.5096	--										
--	0.1743	--	--	0.2183	0.2503	--	--	0.3031	--	--	0.4074	--	0.4823	--										
620	--	0.2675	--	0.3245	--	0.4716	--	--	0.6817	--	--	1.1306	--	1.4390										
753	--	0.2503	--	0.2928	--	0.3994	--	--	0.6170	--	--	1.0444	--	1.3728										

B

Table 1

ORIGINAL WEIGHTS OF THE COATINGS AND THEIR ACTUAL GAIN IN WEIGHT AFTER IMMERSION IN TA

	Gain in weight (grams)											
1	4	6	9	12	18	21	24	30	33	36	40	44
0.0101	--	0.0112	--	0.0137	0.0194	--	0.0273	0.0232	--	--	0.0251	--
0.0099	--	0.0142	--	0.0170	0.0242	--	0.0414	0.0377	--	--	0.0484	--
0.0177	--	0.0283	--	0.0343	0.0415	--	0.0619	0.0616	--	--	0.0767	--
0.0124	--	0.0235	--	0.0320	0.0380	--	0.0497	0.0552	--	--	0.0728	--
0.0075	--	0.0107	--	0.0165	0.0262	--	0.0484	0.0520	--	--	0.0682	--
0.0084	--	0.0122	--	0.0166	0.0303	--	0.0170	0.0204	--	--	0.0396	--
***												
0.0067	--	0.0092	--	0.0167	0.0160	--	0.0196	0.0244	--	--	0.0354	--
0.0288	--	0.1167	--	0.1899	0.5312	--	0.8694	1.7132	--	--	3.0475	--
0.0435	--	0.1406	--	0.2343	0.7795	--	1.5189	2.8543	--	--	4.7120	--
0.0323	--	0.0471	--	0.0986	0.1334	--	0.2190	0.1847	--	--	0.3437	--
0.0274	--	0.0462	--	0.0731	0.0884	--	0.1083	0.1388	--	--	0.2753	--
0.0397	--	0.1038	--	0.1564	0.1969	--	0.2245	0.2594	--	--	0.3285	--
0.0436	--	0.1260	--	0.1788	0.2129	--	0.2480	0.2801	--	--	0.3467	--
-0.0027	--	**0.0047	--	0.0046	0.0147	--	***					
None	--	**None	--	None	0.0008	--	0.0074	0.0098	--	--	0.0239	--
0.0417	0.1102	--	0.1379	--	0.2044	--	--	0.2741	0.3125	--	--	0.380
0.0353	0.0852	--	0.1363	--	0.2112	--	--	0.2698	0.3091	--	--	0.381
0.0409	0.0792	--	0.1190	--	0.1667	--	--	0.2217	0.2615	--	--	0.319
0.0365	0.0634	--	0.1221	--	0.1743	--	--	0.2183	0.2503	--	--	0.303
--	--	0.1440	--	0.1620	--	0.2675	--	0.3245	--	0.4716	--	--
--	--	0.1434	--	0.1753	--	0.2503	--	0.2928	--	0.3994	--	--

1 test.

not a true value.

TAPWATER FOR TIME INTERVALS AS NOTED

ms) at the number of months indicated

44	48	54	60	66	72	78	84	96	120	126	144	1/156	1/176
--	0.0351	0.0429	--	0.0516	--	--	0.1065	0.1448	--	--	2/0.0767		
--	0.0493	0.0532	--	0.0642	--	--	0.1071	0.1388	--	--	2/0.0920		
--	0.0854	0.0872	--	0.1003	--	--	0.1375	0.1728	--	--	0.2606	--	0.3256
--	0.0646	0.0679	--	0.0776	--	--	0.1121	0.1514	--	--	0.2262	--	0.2844
--	0.0840	0.0930	--	0.1191	--	--	0.2154	0.2962	--	--	0.5770	--	0.7045
--	0.0605	0.0697	--	0.1061	--	--	0.1781	0.2641	--	--	0.4701	--	4/
--	0.0392	0.0444	--	0.0580	--	--	0.0792	0.1269	--	--	0.1441	--	0.1669
--	3.4049	****											
--	5.5603	****											
--	0.4477	****											
--	0.3276	****											
--	0.3742	0.4278	--	0.5330	--	--	0.7450	0.9540	--	--	1.5102		
--	0.3801	0.4514	--	0.5633	--	--	0.8311	1.1391	--	--	1.6411		
--	0.0282	0.0369	--	0.0953	--	--	0.1722	0.2846	--	--	0.4588		
3807	--	--	0.5196	--	0.6336	--	--	--	0.9294	--	--	1.1760	
3813	--	--	0.5017	--	0.6198	--	--	--	0.8643	--	--	1.0493	
3193	--	--	0.4298	--	0.5096	--	--	--	3/0.7905				
3031	--	--	0.4074	--	0.4823	--	--	--	3/0.5983				
--	0.6817	--	--	1.1306	--	1.4390	--	--	--	3/2.4355			
--	0.6170	--	--	1.0444	--	1.3728	--	--	--	3/2.3008			

Disc No.	Material	Pen.	Original weight	PERCENT GAIN IN 1	4	6	9	1
1	Microcrystalline wax	--	4.2131	0.24	--	0.27	--	0.
2	Microcrystalline wax	--	4.2603	0.23	--	0.33	--	0.
3	Coal-tar enamel	5	9.8932	0.18	--	0.29	--	0.
4	Coal-tar enamel	5	7.4294	0.17	--	0.32	--	0.
5	Coal-tar enamel	14	11.1088	0.07	--	0.10	--	0.
6	Coal-tar enamel	14	10.1338	0.08	--	0.12	--	0.
7	Coal-tar pitch	11	3.2749					
8	Coal-tar pitch	11	1.5860	0.42	--	0.58	--	1.
9	Asphalt, P_2O_5 catalytically blown	50	4.1385	0.70	--	2.82	--	4.
10	Asphalt, P_2O_5 catalytically blown	50	7.1686	0.61	--	1.96	--	3.
11	Asphalt, air blown	28	4.3924	0.74	--	1.07	--	2.
12	Asphalt, air blown	28	4.2506	0.64	--	1.09	--	1.
13	Asphalt, air blown	11	4.0660	0.98	--	2.55	--	3.
14	Asphalt, air blown	11	3.9507	1.10	--	3.19	--	4.
15	Paraffin	--	2.3409	-0.12	--	0.20	--	0.
16	Paraffin	--	1.3885	None	--	None	--	No
11a	Asphalt enamel	4-8	19.3654	0.22	0.57	--	0.71	--
12a	Asphalt enamel	4-8	20.0615	0.18	0.42	--	0.68	--
13a	Asphalt enamel	6	10.0303	0.41	0.79	--	1.19	--
19	Asphalt enamel	6	10.0135	0.36	0.63	--	1.22	--
18	Asphalt enamel	8	7.7501	--	--	1.86	--	2.
20	Asphalt enamel	8	7.5950	--	--	1.89	--	2.

*Indicates a loss in weight.

1/New data since September 1961.
2/Coating very slimy, partly removed in drying, not a true value.
3/Coating flaking slightly, not a true value.
4/Specimen damaged slightly--No value determined.

Table 2

IN WEIGHT OF COATINGS AFTER IMMERSION IN TAPWATER FOR TIME INTERVALS AS NOTED

Percent gain in weight after months indicated															
12	18	21	24	30	33	36	40	44	48	54	60	66	72	78
0.33	0.46	--	0.65	0.55	--	--	0.60	--	0.83	1.02	--	1.22	--	--
0.40	0.57	--	0.97	0.88	--	--	1.14	--	1.16	1.25	--	1.51	--	--
0.35	0.42	--	0.63	0.62	--	--	0.77	--	0.86	0.88	--	1.01	--	--
0.43	0.51	--	0.67	0.74	--	--	0.98	--	0.87	0.91	--	1.04	--	--
0.15	0.24	--	0.44	0.47	--	--	0.61	--	0.76	0.84	--	1.07	--	--
0.16	0.30	--	0.17	0.20	--	--	0.39	--	0.60	0.69	--	1.05	--	--
1.05	1.01	--	1.24	1.54	--	--	2.23	--	2.47	2.80	--	3.66	--	--
4.59	12.83	--	21.00	41.39	--	--	73.63	--	82.26					
3.27	10.87	--	21.19	39.82	--	--	65.73	--	77.57					
2.25	3.04	--	4.99	4.21	--	--	7.83	--	10.19					
1.72	2.08	--	2.55	3.27	--	--	6.48	--	7.71					
3.85	4.84	--	5.52	6.38	--	--	8.08	--	9.20	10.52	--	13.11	--	--
4.53	5.39	--	6.28	7.09	--	--	8.77	--	9.62	11.42	--	14.26	--	--
0.20	0.63													
None	0.06	--	0.53	0.71	--	--	1.72	--	2.03	2.66	--	6.86	--	--
--	1.06	--	--	1.42	1.61	--	--	1.97	--	--	2.68	--	3.27	--
--	1.05	--	--	1.34	1.54	--	--	1.90	--	--	2.50	--	3.09	--
--	1.66	--	--	2.21	2.61	--	--	3.18	--	--	4.28	--	5.08	--
--	1.74	--	--	2.18	2.50	--	--	3.03	--	--	4.07	--	4.82	--
2.09	--	3.45	--	4.19	--	6.08	--	--	8.79	--	--	14.58	--	18.57
2.31	--	3.30	--	3.86	--	5.26	--	--	8.13	--	--	13.75	--	18.08

B

Table 2

PERCENT GAIN IN WEIGHT OF COATINGS AFTER IMMERSION IN TAPWATER FOR

1:	Percent gain in											
'8 : 84	1	4	6	9	12	18	21	24	30	33	36	40
-- : 2.5?	0.24	--	0.27	--	0.33	0.46	--	0.65	0.55	--	--	0.60
- : 2.5	0.23	--	0.33	--	0.40	0.57	--	0.97	0.88	--	--	1.14
- : 1.3	0.18	--	0.29	--	0.35	0.42	--	0.63	0.62	--	--	0.77
- : 1.5	0.17	--	0.32	--	0.43	0.51	--	0.67	0.74	--	--	0.98
- : 1.9	0.07	--	0.10	--	0.15	0.24	--	0.44	0.47	--	--	0.61
- : 1.7	0.08	--	0.12	--	0.16	0.30	--	0.17	0.20	--	--	0.39
- : 4.9	0.42	--	0.58	--	1.05	1.01	--	1.24	1.54	--	--	2.23
	0.70	--	2.82	--	4.59	12.83	--	21.00	41.39	--	--	73.63
	0.61	--	1.96	--	3.27	10.87	--	21.19	39.82	--	--	65.73
	0.74	--	1.07	--	2.25	3.04	--	4.99	4.21	--	--	7.83
	0.64	--	1.09	--	1.72	2.08	--	2.55	3.27	--	--	6.48
- : 18.3	0.98	--	2.55	--	3.85	4.84	--	5.52	6.38	--	--	8.08
- : 21.0	1.10	--	3.19	--	4.53	5.39	--	6.28	7.09	--	--	8.77
- : 12.4	-0.12	--	0.20	--	0.20	0.63						
	None	--	None	--	None	0.06	--	0.53	0.71	--	--	1.72
- : --	0.22	0.57	--	0.71	--	1.06	--	--	1.42	1.61	--	--
- : --	0.18	0.42	--	0.68	--	1.05	--	--	1.34	1.54	--	--
- : --	0.41	0.79	--	1.19	--	1.66	--	--	2.21	2.61	--	--
- : --	0.36	0.63	--	1.22	--	1.74	--	--	2.18	2.50	--	--
.57: --	--	--	1.86	--	2.09	--	3.45	--	4.19	--	6.08	--
.08: --	--	--	1.89	--	2.31	--	3.30	--	3.86	--	5.26	--

, not a true value.

ied.

FOR TIME INTERVALS AS NOTED

in weight after months indicated

40	44	48	54	60	66	72	78	84	96	120	126	144	1/156	1/17
.60	--	0.83	1.02	--	1.22	--	--	2.53	3.44	--	--	2/1.82		
..14	--	1.16	1.25	--	1.51	--	--	2.51	3.26	--	--	2/2.16		
.77	--	0.86	0.88	--	1.01	--	--	1.39	1.75	--	--	2.63	--	3.2
.98	--	0.87	0.91	--	1.04	--	--	1.51	2.04	--	--	3.04	--	3.8
.61	--	0.76	0.84	--	1.07	--	--	1.94	2.67	--	--	5.19	--	6.3
.39	--	0.60	0.69	--	1.05	--	--	1.76	2.61	--	--	4.64	--	4/
.23	--	2.47	2.80	--	3.66	--	--	4.99	8.00	--	--	9.06	--	10.5
.63	--	82.26												
.73	--	77.57												
.83	--	10.19												
.48	--	7.71												
.08	--	9.20	10.52	--	13.11	--	--	18.32	23.46	--	--	37.14		
.77	--	9.62	11.42	--	14.26	--	--	21.04	28.83	--	--	41.54		
.72	--	2.03	2.66	--	6.86	--	--	12.40	20.54	--	--	33.11		
--	1.97	--	--	2.68	--	3.27	--	--	--	4.80	--	--	6.07	
--	1.90	--	--	2.50	--	3.09	--	--	--	4.31	--	--	5.23	
--	3.18	--	--	4.28	--	5.08	--	--	--	3/7.88				
--	3.03	--	--	4.07	--	4.82	--	--	--	3/5.97				
--	--	8.79	--	--	14.58	--	18.57	--	--	--	3/31.43			
--	--	8.13	--	--	13.75	--	18.08	--	--	--	3/30.29			

2 A

FRAMES

Disc No.	Material	Pen	Original weight	GAIN IN WEIGHT OF COA 1	4	6	9	12
1	Microcrystalline wax	--:	4.2131	0.16:	--	0.18	--	0.22
2	Microcrystalline wax	--:	4.2603	0.16:	--	0.23	--	0.28
3	Coal-tar enamel	5	9.8932	0.29:	--	0.46	--	0.56
4	Coal-tar enamel	5	7.4294	0.20:	--	0.38	--	0.52
5	Coal-tar enamel	14	11.1088	0.12:	--	0.17	--	0.27
6	Coal-tar enamel	14	10.1338	0.14:	--	0.20	--	0.27
7	Coal-tar pitch	11	3.2749					
8	Coal-tar pitch	11	1.5860	0.11:	--	0.15	--	0.27
9	Asphalt, P_2O_5 catalytically-blown	50	4.1385	0.47:	--	1.90	--	3.10
10	Asphalt, P_2O_5 catalytically-blown	50	7.1686	0.71:	--	2.29	--	3.82
11	Asphalt, air blown	28	4.3924	0.53:	--	0.77	--	1.61
12	Asphalt, air blown	28	4.2506	0.45:	--	0.75	--	1.19
13	Asphalt, air blown	11	4.0660	0.65:	--	1.69	--	2.55
14	Asphalt, air blown	11	3.9507	0.71:	--	2.06	--	2.92
15	Paraffin	--	2.3409	*-0.04:	--	0.08	--	0.08
16	Paraffin	--	1.3885	None	--	None	--	None
11a	Asphalt enamel	4-8	19.3654	0.68:	1.80	--	2.25	--
12a	Asphalt enamel	4-8	20.0615	0.58:	1.39	--	2.22	--
13a	Asphalt enamel	6	10.0303	0.67:	1.29	--	1.94	--
19	Asphalt enamel	6	10.0135	0.60:	1.03	--	1.99	--
18	Asphalt enamel	8	7.7501	--	--	2.35	--	2.64
20	Asphalt enamel	8	7.5950	--	--	2.34	--	2.86

*Indicates a loss in weight.

1/New data since September 1961.
2/Coating very slimy, partly removed in drying, not a true value.
3/Coating flaking slightly, not a true value.
4/Specimen damaged slightly--No value determined.

Table 3

COATINGS, REPORTED AS GRAMS PER SQUARE FOOT, AFTER IMMERSION IN TAPWATER FOR TIME INTERVALS AS NOTED

	Gain in weight, grams per square foot, at number of months indicated																
2	18	21	24	30	33	36	40	44	48	54	60	66	72	78			
22	0.32	--	0.45	0.38	--	--	0.41	--	0.57	0.70	--	0.84	--	--			
28	0.39	--	0.68	0.61	--	--	0.79	--	0.80	0.87	--	1.05	--	--			
56	0.68	--	1.01	1.00	--	--	1.25	--	1.39	1.42	--	1.64	--	--			
52	0.62	--	0.81	0.90	--	--	1.19	--	1.05	1.11	--	1.27	--	--			
27	0.43	--	0.79	0.85	--	--	1.11	--	1.37	1.52	--	1.94	--	--			
27	0.49	--	0.28	0.33	--	--	0.65	--	0.99	1.14	--	1.73	--	--			
27	0.26	--	0.32	0.40	--	--	0.58	--	0.64	0.72	--	0.95	--	--			
10	8.66	--	14.18	27.94	--	--	49.70	--	55.53								
82	12.71	--	24.77	46.55	--	--	76.85	--	90.69								
51	2.18	--	3.57	3.01	--	--	5.61	--	7.30								
19	1.44	--	1.77	2.26	--	--	4.49	--	5.34								
55	3.21	--	3.66	4.23	--	--	5.36	--	6.10	6.98	--	8.69	--	--	12		
92	3.47	--	4.04	4.57	--	--	5.65	--	6.20	7.36	--	9.19	--	--	13		
08	0.24																
ne	0.01	--	0.12	0.16	--	--	0.39	--	0.46	0.60	--	1.55	--	--	2		
-	3.33	--	--	4.47	5.10	--	--	6.21	--	--	8.47	--	8.47	--	-		
-	3.44	--	--	4.40	5.04	--	--	6.22	--	--	8.18	--	8.18	--	-		
-	2.72	--	--	3.62	4.27	--	--	5.21	--	--	7.01	--	7.01	--	-		
-	2.84	--	--	3.56	4.08	--	--	4.94	--	--	6.64	--	6.64	--	-		
54	--	4.36	--	5.29	--	7.69	--	--	11.12	--	--	18.44	--	23.47	-		
36	--	4.08	--	4.78	--	6.51	--	--	10.06	--	--	17.03	--	22.39	-		

B

Table 3

GAIN IN WEIGHT OF COATINGS, REPORTED AS GRAMS PER SQUARE FOOT, AFTER IMMERSI

nal:	Gain in weight, grams per sq												
ht	1	4	6	9	12	18	21	24	30	33	36	40	44
31	0.16	--	0.18	--	0.22	0.32	--	0.45	0.38	--	--	0.41	--
03	0.16	--	0.23	--	0.28	0.39	--	0.68	0.61	--	--	0.79	--
32	0.29	--	0.46	--	0.56	0.68	--	1.01	1.00	--	--	1.25	--
94	0.20	--	0.38	--	0.52	0.62	--	0.81	0.90	--	--	1.19	--
88	0.12	--	0.17	--	0.27	0.43	--	0.79	0.85	--	--	1.11	--
38	0.14	--	0.20	--	0.27	0.49	--	0.28	0.33	--	--	0.65	--
49													
60	0.11	--	0.15	--	0.27	0.26	--	0.32	0.40	--	--	0.58	--
35	0.47	--	1.90	--	3.10	8.66	--	14.18	27.94	--	--	49.70	--
86	0.71	--	2.29	--	3.82	12.71	--	24.77	46.55	--	--	76.85	--
24	0.53	--	0.77	--	1.61	2.18	--	3.57	3.01	--	--	5.61	--
06	0.45	--	0.75	--	1.19	1.44	--	1.77	2.26	--	--	4.49	--
60	0.65	--	1.69	--	2.55	3.21	--	3.66	4.23	--	--	5.36	--
07	0.71	--	2.06	--	2.92	3.47	--	4.04	4.57	--	--	5.65	--
09	*-0.04	--	0.08	--	0.08	0.24							
35	None	--	None	--	None	0.01	--	0.12	0.16	--	--	0.39	--
54	0.68	1.80	--	2.25	--	3.33	--	--	4.47	5.10	--	--	6.21
15	0.58	1.39	--	2.22	--	3.44	--	--	4.40	5.04	--	--	6.22
03	0.67	1.29	--	1.94	--	2.72	--	--	3.62	4.27	--	--	5.21
35	0.60	1.03	--	1.99	--	2.84	--	--	3.56	4.08	--	--	4.94
01	--	--	2.35	--	2.64	--	4.36	--	5.29	--	7.59	--	--
50	--	--	2.34	--	2.86	--	4.08	--	4.78	--	6.51	--	--

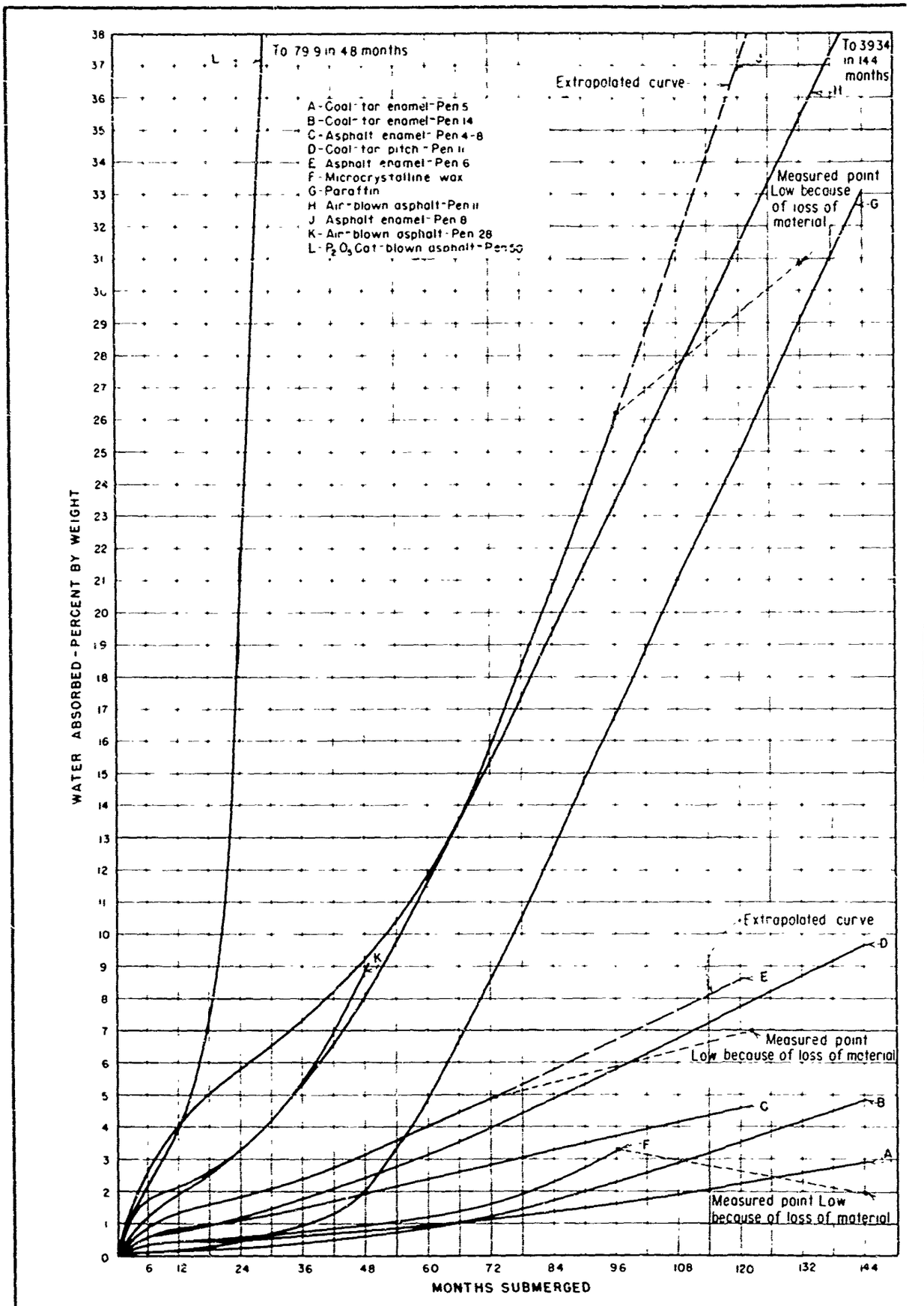
ng, not a true value.

.

ined.

ERSION IN TAPWATER FOR TIME INTERVALS AS NOTED
square foot, at number of months indicated

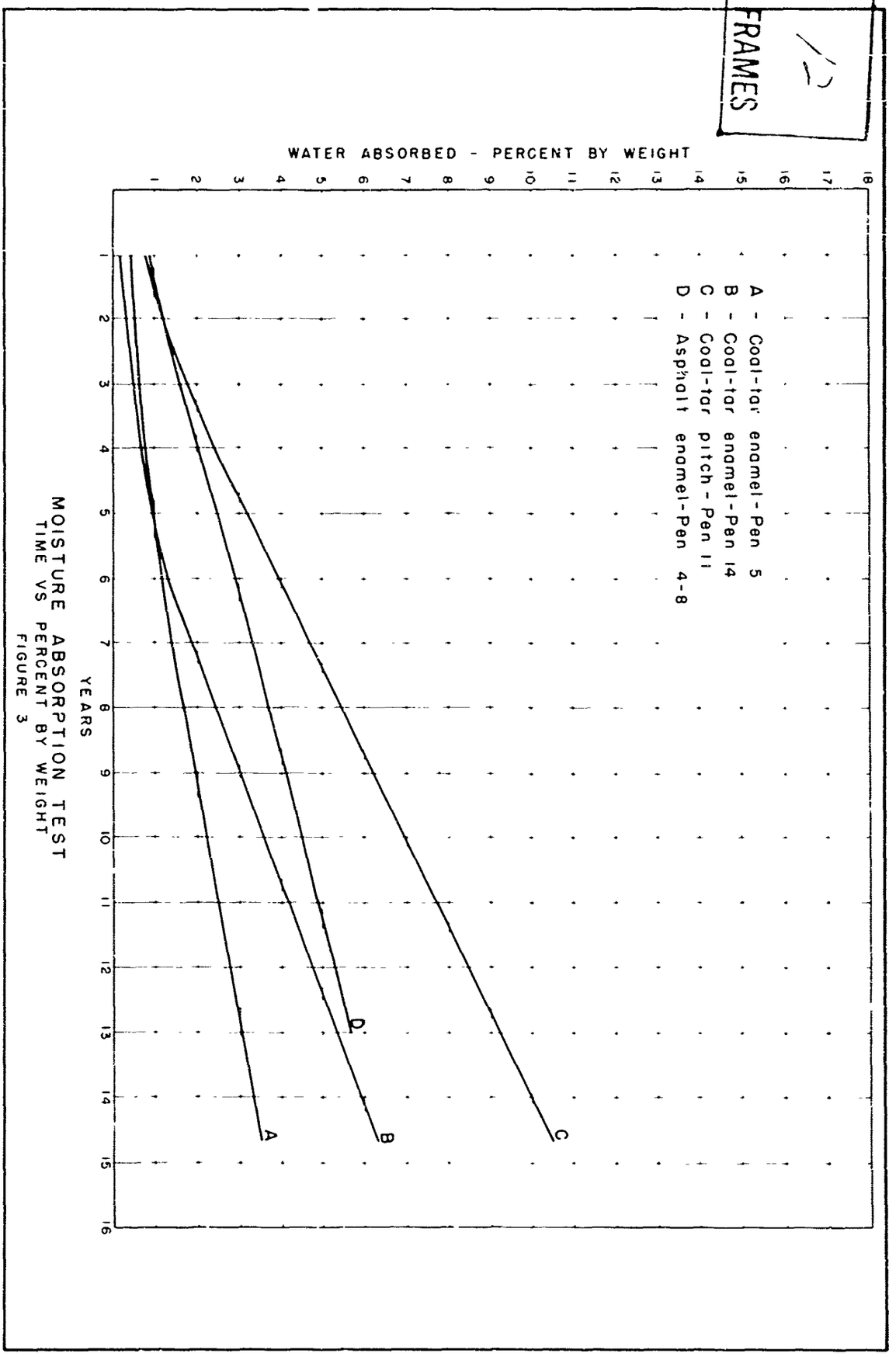
44	48	54	60	66	72	78	84	96	120	126	144	1/156	1/176
--	0.57	0.70	--	0.84	--	--	1.74	2.36	--	--	2/1.25		
--	0.80	0.87	--	1.05	--	--	1.75	2.26	--	--	2/1.50		
--	1.39	1.42	--	1.64	--	--	2.24	2.82	--	--	4.25	--	5.31
--	1.05	1.11	--	1.27	--	--	1.83	2.47	--	--	3.69	--	4.64
--	1.37	1.52	--	1.94	--	--	3.51	4.83	--	--	9.41	--	11.49
--	0.99	1.14	--	1.73	--	--	2.90	4.31	--	--	7.67	--	4/
--	0.64	0.72	--	0.95	--	--	1.29	2.07	--	--	2.35	--	2.72
--	55.53												
--	90.69												
--	7.30												
--	5.34												
--	6.10	6.98	--	8.69	--	--	12.15	15.56	--	--	24.63		
--	6.20	7.36	--	9.19	--	--	13.56	18.58	--	--	26.77		
--	0.46	0.60	--	1.55	--	--	2.81	4.64	--	--	7.48		
.21	--	--	8.47	--	8.47	--	--	--	15.16	--	--	19.18	
.22	--	--	8.18	--	8.18	--	--	--	14.10	--	--	17.11	
.21	--	--	7.01	--	7.01	--	--	--	3/12.89				
.94	--	--	6.64	--	6.64	--	--	--	3/ 9.76				
--	11.12	--	--	18.44	--	23.47	--	--	--	3/39.72			
--	10.06	--	--	17.03	--	22.39	--	--	--	3/37.53			



MOISTURE ABSORPTION TESTS

TIME VS PERCENT BY WEIGHT

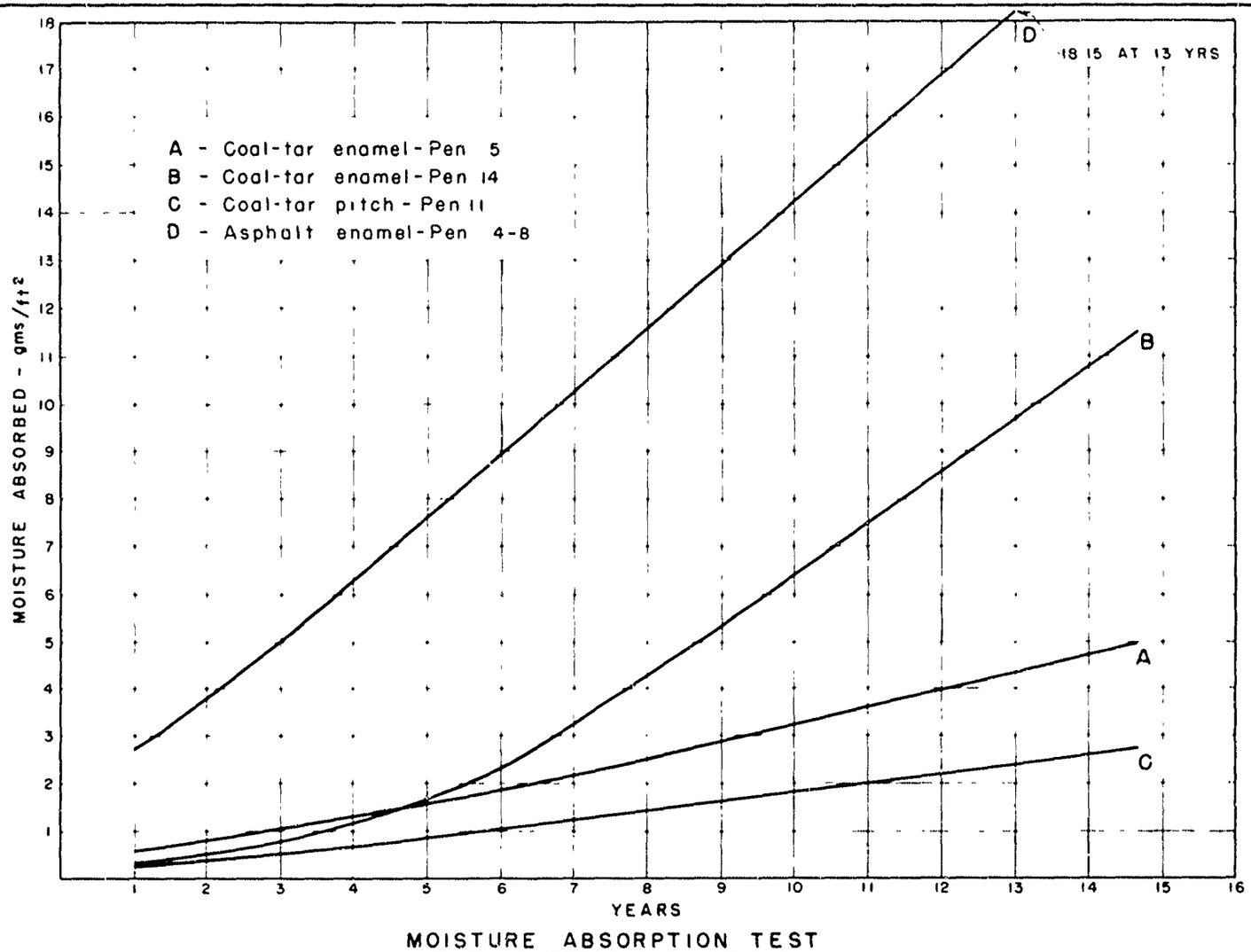
FIGURE 1



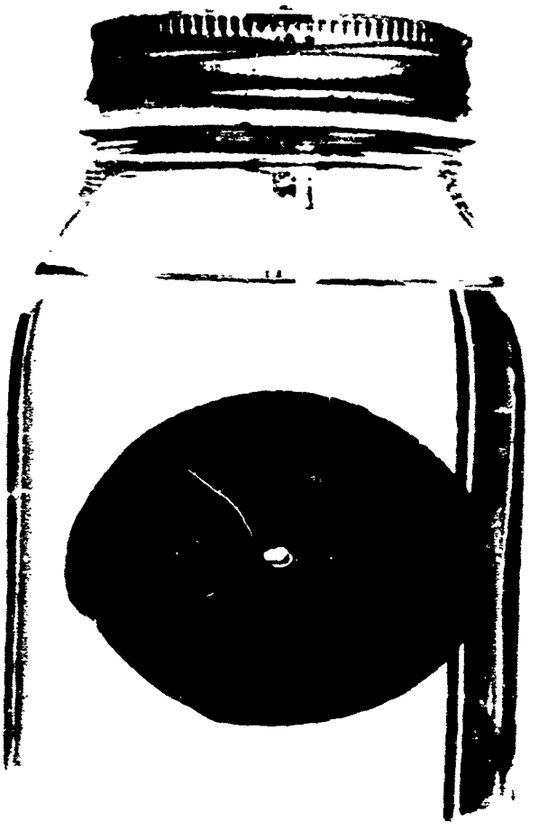
MOISTURE ABSORPTION TEST
TIME VS PERCENT BY WEIGHT
FIGURE 3

1/2

FRAMES



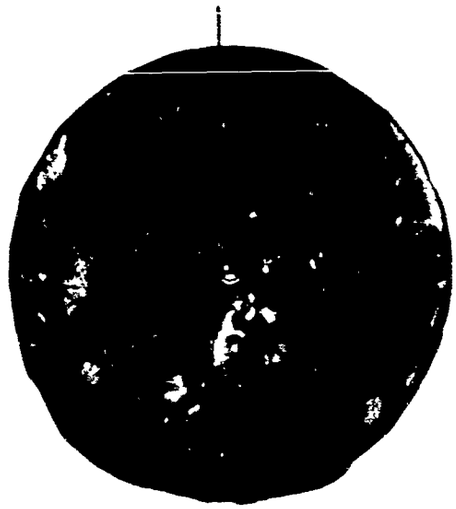
MOISTURE ABSORPTION TEST
TIME VS. PERCENT BY WEIGHT
FIGURE 4



MOISTURE ABSORPTION TEST SPECIMEN

PX-D-29362

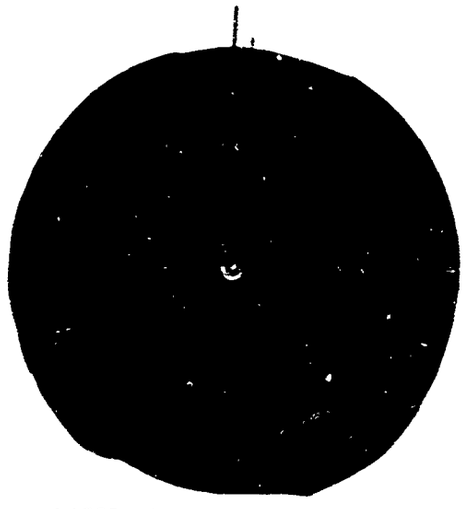
Figure 5



PX-D-44554 NA

CH-483-51NA

Disc No. 4
Coal-tar enamel,
Pen. 5, after 176 months' immersion.



PX-D-44555 NA

CH-483-52NA

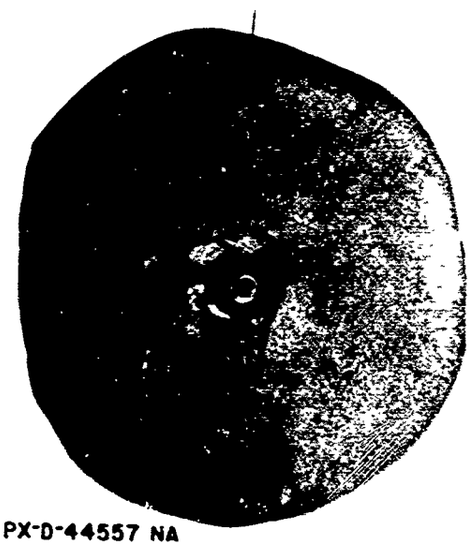
Disc No. 5
Coal-tar enamel,
Pen. 14, after 176 months' immersion.

Figure 6

PX-D-44556 NA

CH-483-53NA

Disc No. 8
Coal-tar pitch,
Pen. 11, after 176 months' immersion.



PX-D-44557 NA

CH-483-54NA

Disc No. 12a
Asphalt enamel,
Pen. 4-8, after 156 months' immersion.

Figure 7